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(54) **Projectile surveillance apparatus.**

(57) A surveillance apparatus which comprises a projectile for firing toward a region to be surveyed, housed within the body (1) of the projectile a payload capsule (9) and, incorporated within the projectile, an expulsion charge (39), the projectile body (1) having a construction which splits when the expulsion charge (39) is initiated permitting the payload capsule (9) to be ejected from the body (1), the payload body having means (11) to retard its forward motion and carrying a surveillance camera (23) and a video transmitter (25), the camera being arranged so as to survey, in operation, the region in front of the capsule (9) and to provide its output as an input signal to the transmitter, the projectile and/or the capsule being provided with means (27) for substantially eliminating the spin of the capsule thereby allowing the picture recorded by the camera to be substantially stabilised.

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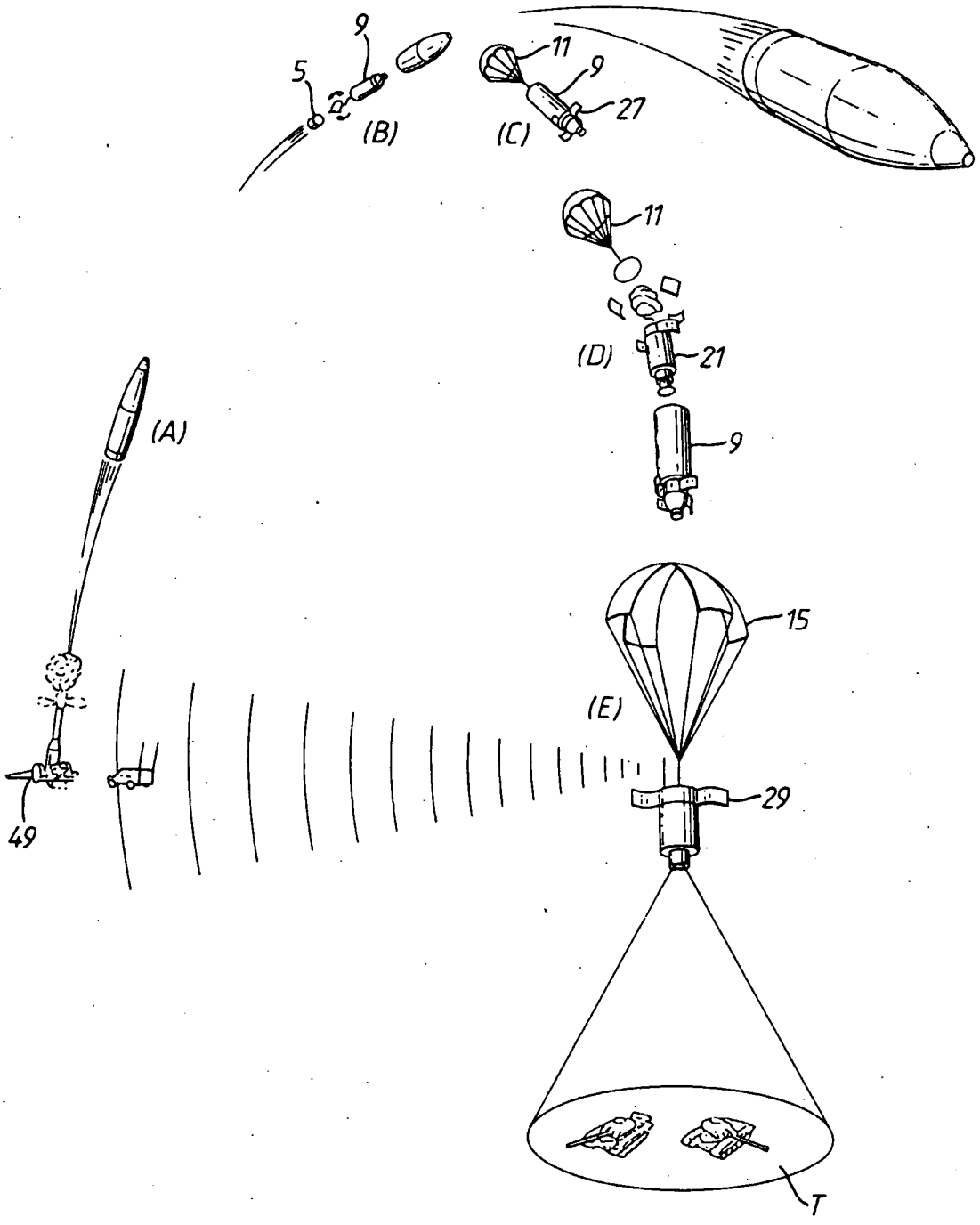
Fig. 2.



The present invention relates to projectile surveillance apparatus.

In a battlefield scenario it is desirable to be able to survey the landscape remotely. The present invention is concerned with surveying the landscape by firing from a gun or other conventional propulsion means over the area to be observed a projectile carrying an arrangement for recording and transmitting images to a remote receiver.

According to the present invention a surveillance apparatus comprises a projectile for firing toward a region to be surveyed, housed within the body of the projectile a payload capsule and, incorporated within the projectile, an expulsion charge, the projectile body having a construction which splits when the expulsion charge is initiated permitting the payload capsule to be ejected from the body, the payload body having means to retard its forward motion and carrying a surveillance camera and a video transmitter, the camera being arranged so as to survey, in operation, the region in front of the capsule and to provide its output as an input signal to the transmitter the projectile and/or the capsule being provided with means for substantially eliminating the spin of the capsule thereby allowing the picture recorded by the camera to be substantially stabilised.

It has been reported in a recent publication that a video imaging projectile has been developed which consists of an artillery shell incorporating a single photodiode that looks through a lucite window in the shell. As the shell passes over the area of interest the scene information detected by the spinning photodiode is digitized and transmitted by radio link to the ground where the image is reconstructed on a computer.

The concept of the apparatus according to the present invention was invented and a practical design was developed before the aforementioned publication and therefore owes no causal link to that publication. Nevertheless, the apparatus according to the present invention is substantially different from the said projectile of the said publication and shows the following unexpected advantages. By ejecting the payload capsule from the projectile and retarding the forward motion and the spin of the capsule the camera carried on the capsule is able to provide to the transmitter real time stabilised picture signals of the scene in front of the camera over a relatively long surveillance period in a selected, localised region at a relatively low height, eg. 500m and less, above the ground. The signals transmitted to a remote receiver can be displayed on a suitable display to which the receiver is connected without the need for substantial signal processing (other than as normally employed to convert a transmitted carrier signal into a display picture) either at the transmitter or receiver end.

In contrast, the signals produced by the detector of the projectile of the said publication would require signal processing to be carried out at both the transmitter and receiver ends in order to produce a stabilised picture, the signal processing would be required to register the precise trajectory shape and spin rate of the projectile. Since these parameters can be affected by such environmental factors as wind and rain causing signal processing errors, the received picture signal may be adversely affected. Because of inevitable delays by the signal processing the picture signal displayed is not a real-time representation of the scene surveyed as the projectile carrying the spinning detector will normally travel rapidly over the surveyed area at an appreciable height above the ground the period of surveillance of a given target region of interest may be unacceptably low.

In the apparatus according to the present invention, the expulsion charge may be arranged to be initiated by a fuze, which may be a conventional time fuze which operates after a set period of time after firing of the projectile the time being pre-determined to select the area of ground to be surveyed by the apparatus.

The said means for substantially eliminating the spin of the capsule may comprise a spring loaded fin assembly providing in operation fins projecting laterally with respect to the axis of spin of the capsule - thereby resisting the spin. The fins may have a concave curvature facing the targential direction of spin to assist the retarding action.

In a preferred form of the invention, the payload capsule may itself incorporate an inner capsule which is adapted to be separated from the payload capsule and its retarding means comprising parachute and fins. The inner capsule may itself have a parachute attached thereto by a flexible coupling further to retard its forward motion and a spring loaded fin assembly providing in operation further laterally projecting fins to retard the spin of the inner capsule. The inner capsule carries the camera, transmitter and their power source which may comprise a conventional thermal or lithium battery. The battery may be arranged to be activated when the payload capsule is separated from the projectile so that after the flight of the inner capsule has been stabilised following its separation from the payload capsule the camera and transmitter are operational.

In the said preferred form of the invention the inner capsule may be separated from the payload capsule by a secondary separation charge. The secondary separation charge may be initiated a predetermined time after the aforementioned (primary) separation charge by a conventional pyrotechnic delay ignition train between the two charges.

The parachute attached to the inner capsule may advantageously be larger than that attached to the payload capsule. If a single large parachute is applied from a capsule travelling at the projectile forward speed there is a significant risk of the parachute being

ripped and/or tangled. By retarding the inner capsule in two stages in the preferred form as described this risk is avoided.

The said camera may comprise a conventional television camera operating in the visible and/or infrared spectral region (ie. detecting either a visual or thermal image of the surveyed region). It may for example comprise a known charge coupled device (CCD) photoconductive array. The video transmitter arranged to transmit electromagnetic signals corresponding to the detected picture may operate in any of the conventional television frequencies. A conventional television receiver receiving pictures transmitted by the transmitter may be at a remote command site and operated and observed by a person who is in radio contact with persons who are in different locations. Alternatively, the persons could carry man-portable receiver packs to observe pictures of the surveyed region themselves.

A plurality of projectiles each comprising apparatus according to the present invention may be deployed to survey a given region. It may be advantageous to transmit the signals from the various transmitters on such projectiles at different frequencies so that the origin of the received signal can be designated. This may be achieved by incorporating within each apparatus a device permitting the transmitter to operate at one of a number of frequencies and a switch for pre-selecting the frequency. The switch may be conveniently be set electrically by applying a suitable current pulse to contact studs on the outside of the projectile body.

There are various modes of operation of parachutes and these may be employed in the parachute(s) used to retard the capsule(s) carrying the camera, transmitter and their power source. These modes include so-called skyhook and glide modes as well as a free-fall mode.

The said projectile may comprise a carrier shell for firing from a howitzer, eg. having one of the widely used calibres, eg. 155mm, 105mm, 4.5 inches or 76mm. Alternatively it may comprise a mortar projectile for firing from a conventional mortar tube.

The packaging of the various components of the apparatus within the projectile need to be "gun hardened" so that they can withstand the setback forces produced upon the projectile being fired. The apparatus may comprise a lens, video camera, thermal battery and transmitter, all of which have been encapsulated in suitable packs to ruggedise them.

Where the projectile is an artillery shell this may carry a range extending device such as a base bleed unit to extend its normal range by reducing its base drag. Such a unit if employed is preferably of a known screw-in type.

The projectile body when split by the expulsion charge may be split by blowing out its base bleed unit. Alternatively, it may be split at a predefined zone of weakness elsewhere on its surface.

The expulsion charge may comprise known solid propellant charges, eg. similar to those used in gas operated actuators.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional side elevation of a surveillance shell embodying the present invention.

Figure 2 is a schematic flow diagram illustrating the various stages of operation of the shell shown in Figure 1.

The shell shown in Figure 1 has a body 1 carrying a driving band 2 and has at its front end a mechanical time fuze 3 and its rear end a base bleed unit 5 attached by a screw thread joint 7 to the side of the body 1.

The base bleed unit 5 is provided to extend the normal range of the shell body 1. Housed inside the body 1 is an expulsion payload tube 9 and its contents together with a drag parachute 11 for the payload tube 9 packed inside the space between the rear end of the tube 9, the inside wall of the body 1 and the wall of the base bleed unit 5.

The drag parachute 11 is attached by a flexible coupling 13 to a rear end cap 14 fitted on the payload tube 9. The end cap 14 forms an inner tubular sleeve 16 within the tube 9 which has a shear ring 18 providing a zone of weakness in the end cap 14. A main parachute 15 is packed inside the sleeve 16 in front of the rear portion of the end cap 14.

An inner tube 21 is provided inside the payload tube 9 in front of the parachute 15. The rear end of the inner tube 21 is formed by a housing 17 to which the main parachute 15 is attached by a flexible coupling 19. The housing 17 houses a container 20 for a thermal battery.

The inner tube 21 incorporates a video camera 23 located in front of and electrically connected to and arranged to provide an input to a uhf (video) transmitter 25. A lens 26 is fitted in front of the camera 23.

The payload tube 9 on its outer side wall at its front end, carries a fin assembly 27 comprising a set of four spring-loaded retarder fins and the housing 17 carries on its outer side wall a fin assembly 29 comprising a set of two spring-loaded retarder fins. The fin assembly 29 and the battery housing 17 attached to it form a rear closure for the inner tube 21.

The front end of the payload tube 9 is in the form of a forward facing projection 31 having on its outer surface a forward facing recess 33 and on its inner surface a rearward facing recess 35. The rearward facing recess 35 houses a secondary expulsion charge 37 and the forward facing recess 33 receives a primary expulsion charge 39 also attached to and arranged to be energised by the fuze 3. The charges 37, 39 are linked by a delay pyrotechnic train 38.

The operation sequence of the surveillance shell

shown in Figure 1 is illustrated in Figure 2. The shell is fired in a conventional manner from a howitzer 49. It is spun during firing by its driving band 2. The spinning shell is illustrated at this first stage by symbol A in Figure 2. After a predetermined time of flight the fuze 3 operates to initiate the primary expulsion charge 39 which expels the payload tube 9 from the body 1 by blowing out the base bleed unit 5. This second stage is illustrated by symbol B in Figure 2. The fins of the assembly 27 are allowed to open at the second stage and these fins retard the spin of the tube 9. The drag parachute 11 is allowed to open and the tube 9 with the parachute 11 retarding its forward motion of is illustrated at the stage illustrated by symbol C in Figure 2.

After a further delay determined by the burning time of the delay ignition train the secondary expulsion charge 37 is initiated causing the inner tube 21 to be expelled from the payload tube 9 by blowing out the end cap 14 at the shear ring 18 thereby also detaching the drag parachute 11. This stage is illustrated by symbol D in Figure 2.

Finally, the fins of the assembly 29 and the main parachute 15 open further retarding the spin and forward motion of the inner tube 21 allowing the tube 21 to fall to the ground slowly over a period of typically 5 to 6 minutes. This final stage is illustrated by symbol E in Figure 2.

The thermal battery (not shown) inside the housing 17 is activated at stage B. The battery begins to energise electrically the appliances connected to it, namely the camera 23 and transmitter 25 and by the time the inner tube 21 reaches stage E the camera 23 and transmitter 25 are operational allowing radio signals and describing the picture of a target T observed by the camera 23 to be transmitted by the transmitter 25 to a remote receiver (not shown).

Claims

1. A surveillance apparatus which comprises a projectile for firing toward a region to be surveyed, housed within the body of the projectile a payload capsule and, incorporated within the projectile, an expulsion charge, the projectile body having a construction which splits when the expulsion charge is initiated permitting the payload capsule to be ejected from the body, the payload body having means to retard its forward motion and carrying a surveillance camera and a video transmitter, the camera being arranged so as to survey, in operation, the region in front of the capsule and to provide its output as an input signal to the transmitter the projectile and/or the capsule being provided with means for substantially eliminating the spin of the capsule thereby allowing the picture recorded by the camera to be substantially stabilised.

2. Apparatus as claimed in Claim 1 and wherein the said means for substantially eliminating the spin of the capsule comprises a spring loaded fin assembly providing in operation fins projecting laterally with respect to the axis spin of the capsule thereby resisting the spin.

3. Apparatus as claimed in Claim 2 and wherein the fins have a concave curvature facing the tangential direction of spin to assist the retarding action.

4. Apparatus as claimed in any one of Claims 1 to 3 and wherein the payload capsule itself incorporates an inner capsule which is adapted to be separated from the payload capsule its retarding means comprising parachute and fins.

5. Apparatus as claimed in Claim 4 and wherein the inner capsule itself has a parachute attached thereto by a flexible coupling further to retard its forward motion and a spring loaded fin assembly providing in operation further laterally projecting fins to retard the spin of the inner capsule, the inner capsule carrying the camera, transmitter and their power source.

6. Apparatus as claimed in Claim 4 or Claim 5 and wherein the inner capsule is arranged to be separated from the payload capsule by a secondary separation charge which may be initiated a predetermined time after the aforementioned (primary) separation charge by a conventional pyrotechnic delay ignition train between the two charges.

7. Apparatus as claimed in any one of Claims 4 to 6 and wherein the parachute attached to the inner capsule is larger than that attached to the payload capsule.

8. A plurality of projectiles each comprising apparatus according to any one of Claims 1 to 5 which projectile may be deployed to survey a given region, the signals from the various transmitters on such projectiles capable of transmitting at different frequencies so that the origin of the received signal can be designated.

9. Apparatus as claimed in Claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

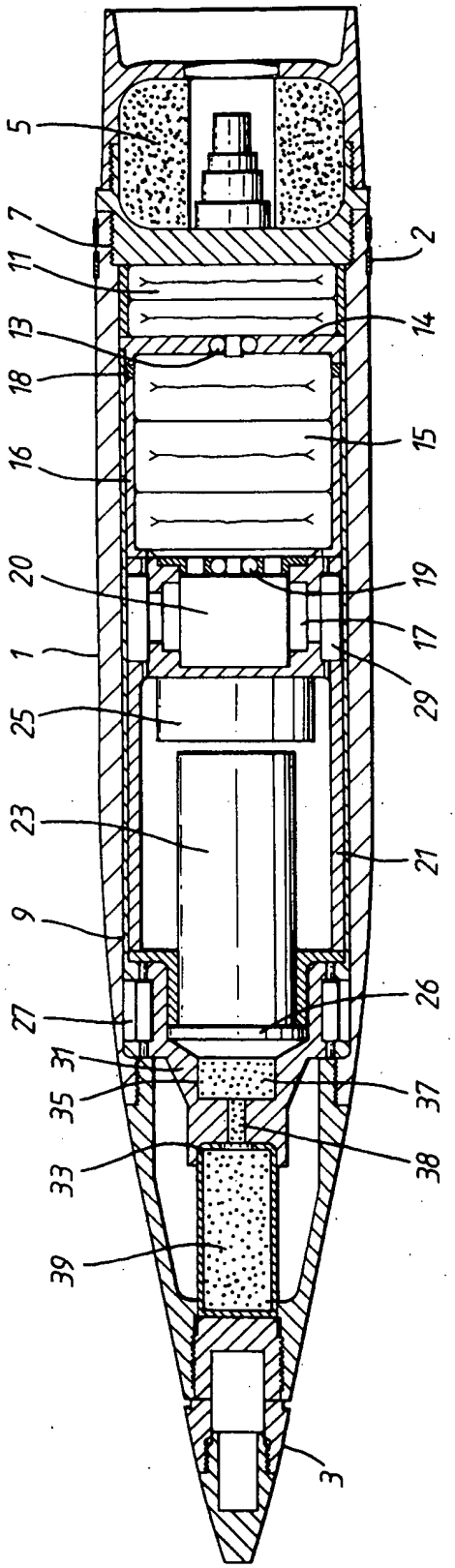
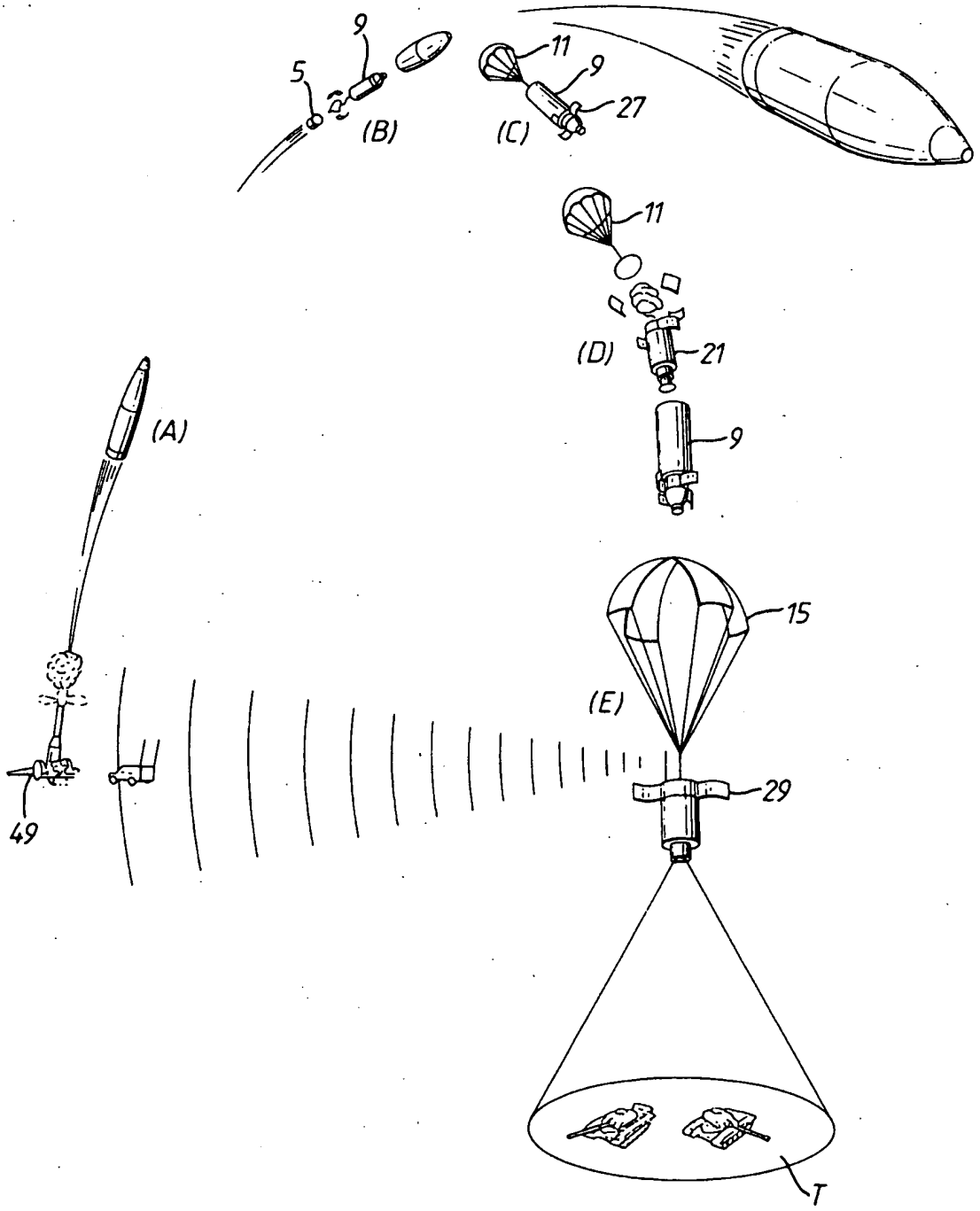


Fig. 1.

Fig. 2.



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EUROPEAN SEARCH REPORT

Application Number

EP 91 30 6333

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-3 962 537 (KEARNS ET AL) * column 1, line 42 - line 61 * * column 2, line 18 - line 27 * * column 3, line 5 - column 4, line 10; claim 1; figures *	1-3,8,9	F42B10/54 F42B12/62 F41G3/02
Y	---	4-7	
Y	FR-A-2 260 772 (ETAT FRANCAIS) * page 1, line 28 - line 37 * * page 3, line 11 - line 23 * * page 4, line 23 - page 6, line 24; figures *	4-7	
A	---	1-3	
A	US-A-4 267 562 (RAIMONDI) * column 11, line 20 - line 29 * * column 11, line 51 - line 63; claim 8; figure 2 *	1,8,9	
Y	---	1-9	
	FR-A-2 541 444 (THOMSON CSF) * page 2, line 16 - page 3, line 3 * * page 6, line 27 - page 7, line 12 * * page 9, line 5 - line 23 * * page 12, line 3 - line 24 * * page 13, line 30 - page 15, line 11; figures 2,7 *		TECHNICAL FIELDS SEARCHED (Int. Cl.5) F42B F41G
Y	---	1-9	
	DE-A-2 429 912 (AB BOFORS) * page 1, paragraph 1 - page 2, paragraph 1 * * page 4, paragraph 3 - page 6, paragraph 1 * * page 7, paragraph 1 - page 12, paragraph 1; claim 1; figures *		
A	---		
	DE-U-8 703 985 (DIEHL GMBH) * page 3, line 2 - page 4, line 13; claims; figures *		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 OCTOBER 1991	DOUSKAS K.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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